Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/630
CZECHOSLOVAKIA
February 1964
Submitted in:
ENGLISH and RUSSIAN

Confidential until official release during Conference

Abstract

ON SOME PHYSICAL PROBLEMS OF THE URANIUM BURN-UP IN HEAVY WATER REACTOR

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The calculation of the uranium burn-up in heavy water heterogeneous reactors consists of the solution of fuel balance equations system, of the fission products influence calculation and of the long-term kinetics calculation based on the two-group theory. The dependence of the neutrons multiplication coefficient on irradiation (integral flux) in the point of homogenizable medium (so-called macro-burn-up) is numerically determined with the help of the BODKUR 2 programme for the automatic computer Ural 2.

The actual burn-up of uranium (micro-burn-up) in a reactor is given by the way of fuel discharge in the reactor. For the case of continuous discharge of the whole fuel elements, when there are elements in the most varied stages of burn-up in the reactor, the micro-burn-up is a simple function of the macro-burn-up and its calculation is included in the BODKUR 2 programme. The results of calculations show that in the operating extension of the burn-up of natural uranium in a heavy water reactor the dependence of reactivity on irradiation can be with satisfactory accuracy approximated by the quadratic curve and thus the further analysis is substantially facilitated.

From the point of view of the original operation of a reactor one question is important: that of the transition of the reactor from the original state - with all elements being fresh - to the equilibrious state with continuous discharge, when there are elements of different burn-up in the reactor, ranging from entirely fresh to the completely burnt-up ones. It appears that when choosing the actual way of operation in the transient state the following requirements are necessary to be kept in view:

1. The minimum length of the transient state of the reactor both from the point of view of reactivity and replacement of elements;
2. The maximum necessary radial stability of the element;
3. The maximum attainable burn-up of fuel;
4. The maximum necessary velocity of the elements replacement.

The circle of suitable ways of transition is limited by these requirements. In the paper a few transition ways are discussed and it is shown that if the maximum permissible irradiation of elements in the equilibrious state is decisive, then, at any kind of transition from the original to the equilibrious state, the burn-up of one half of the average equilibrious irradiation of one fuel charge always will be lost.

In addition to the discharge of the whole elements there are, of course, other ways of fuel shuffling in a reactor. One of them is e.g. the continuous shuffling of fuel in the direction of the reactor axis. In the paper is investigated the axial flux distribution and the attainable burn-up for the fuel shuffling in one direction, the shuffling in opposite direction (one half of fuel moves in one direction and the other in opposite direction) and the regressive shuffling (the fuel returns back after reaching the second base of reactor).

During these studies the problem of the accuracy of thermal parameters of a reactor occurred. An attempt was made - that of application of thermodynamics of irreversible processes on the calculation of effective temperature of neutron gas. The received results for the homogeneous and heterogeneous medium are in agreement with those introduced in literature.